

SAINT CROIX RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

RELATIVE TO

The improvement of the Saint Croix River.

FEBRUARY 11, 1880.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 10, 1880.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the resolution of that body of the 4th instant, calling for all reports relating to the improvement of the Saint Croix River in the States of Wisconsin and Minnesota received by the Secretary of War from the local engineer in charge since the submission of his annual report, a letter from the Chief of Engineers, and accompanying copy of report of Capt. C. J. Allen, Corps of Engineers, dated January 26, 1880, on the survey of a portion of said river.

ALEX. RAMSEY,
Secretary of War.

The SPEAKER
Of the House of Representatives.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 9, 1880.

SIR: I have the honor to return herewith the resolution of the House of Representatives of the 4th instant, referred to this office for report, requesting the Secretary of War "to transmit to this House all reports relating to the improvement of the Saint Croix River in the States of Wisconsin and Minnesota received by him from the local engineer in charge since the submission of his annual report," and in compliance therewith to transmit the accompanying copy of the report of Capt. C. J. Allen, Corps of Engineers, on the survey of the Saint Croix River from Taylor's Falls, the head of steamboat navigation, to Prescott, dated January 26, 1880.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers, Brig. and Bvt. Maj. Gen., U. S. A.

Hon. ALEXANDER RAMSEY,
Secretary of War.

SURVEY OF SAINT CROIX RIVER FROM TAYLOR'S FALLS, THE HEAD OF STEAMBOAT NAVIGATION, TO PRESCOTT.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, January 26, 1880.

GENERAL: I have the honor to report the results of a survey of the Saint Croix River, Minnesota and Wisconsin, made in accordance with authority from the Chief of Engineers, as per letters of the 14th and 23d of May, 1879.

Early in August, as soon as the stand of water approached the low-water stage, a party was organized and placed in charge of Assistant Engineer Frederick Terry, assisted by Messrs. J. B. Parkinson and E. A. Guill, assistant engineers, to survey the river from Taylor's Falls, the head of steamboat navigation, to Prescott, at the confluence of the Saint Croix and Mississippi, the total distance being about 52 miles. The operations of the survey consisted in the usual triangulation, meanderings, soundings, and gaugings of the discharge; in addition, full lines of level were run over the entire distance, giving the fall. The levels are all referred to sea-level. The party returned to this city on the 24th of October, 1879, having satisfactorily performed the duties required, and was immediately transferred to the survey of the Mississippi between Saint Paul and the Falls of Saint Anthony, said survey having been ordered by section 2, act of Congress approved March 3, 1879. It was considered as in the interest of economy to thus transfer the party. Upon the completion of the latter-named survey, the party returned to Saint Paul and projected maps of the Saint Croix River.

The course of the Saint Croix between Taylor's Falls and Prescott is unusually direct for a stream flowing over an alluvial bed. But few curves occur. The material composing the bed is sand, gravel, some boulders, and some clay. The banks are subject to wash. The channel is divided by a large number of islands, forming secondary channels, chutes, and sloughs, which are largely utilized by the logging interests for storage and distribution of logs. The banks are, alternately, bottom and bluff; the former about 8 to 10 feet above low-water; the latter rising as high as 150 feet. At the Dalles the trap rock rises precipitously from the water's edge. The river is fed by numerous streams, ranging from the smallest creeks upwards. The Apple and Kinnickinnick rivers contribute large quantities of gravel, and all of them more or less gravel, sand, and mud. As might be expected, frequent changes in the channel have occurred, especially after the spring freshets. The low-water volume at Taylor's Falls is about 1,900 cubic feet per second; at McLeod's Lake, about 14 miles below the falls, it is 2,300 cubic feet per second; and at the foot of the lake about 2,800 cubic feet per second. The average low-water slope from Taylor's Falls to Stillwater, at the head of the lake, is 0.605 feet per mile.

The range of water surface at Taylor's Falls Landing, below the Dalles, is 11 feet; at Stillwater, 10 feet; and at Prescott, where the Mississippi exerts a strong influence, it is about 22 feet. The stage of water in the river is much affected, also, by the operations of the dams above the Dalles, these dams being used by loggers for the purpose of creating a driving stage for logs. This has, however, been referred to in my report of December 9, 1878, upon the Saint Croix.

The obstructions to navigation, viz, piers, snags, leaning trees, bowlders, sand-bars, &c., are also referred to in that report and in preceding ones. The stream is navigated by steamers and barges; and, in addition,

by rafts below Stillwater. Three feet to 3½ feet depth in the channel at lowest water generally satisfies the wants of steamers plying above Stillwater. To insure the depth required the low-water width of the stream must be contracted at a number of points to 400 feet.

The survey commenced at the Dalles Bridge, although a bench-mark was established at a point on the Minnesota side about 4,000 feet above the bridge. From that point to the Taylor's Falls Landing, a distance of about 5,600 feet, the fall of the low-water surface was ascertained to be 19.27 feet; the greater part of the fall accumulating at the portion of the Dalles spanned by the bridge.

During the earlier period of the survey and until McLeod's Lake was reached the stage of water averaged 2.6 feet above low-water; during the rest of the survey the gauge indicated about 6 inches above that plane. The actual soundings are plotted, but the curve projected on the maps herewith in red is a 3-foot curve reduced to low-water. Much of the good depth of water indicated on the maps is due to the removal of obstructions and other work performed by the United States in 1878 and 1879.

The first place below the Dalles where shoal water was found during the survey is in the vicinity of Islands 1 and 2 (see map). Between Island No. 2 and the right bank is a channel known as Clark's Slough, which, although encumbered more or less by old cribs, &c., has for several seasons possessed better depth of water than the left-hand channel. A large number of cribs and other obstructions were removed by the United States in 1878, and the material utilized in the repair and extension of the wing-dam at the upper end of the island (shown in black on the map). The right bank of the island was also revetted during the same season. The result has been a good channel. After heavy storms in summer, however, the torrents issuing through the ravines leading from the bluffs on the right bank carry sand into this channel, a notable instance of such action having occurred during the season of 1879. To keep this channel up to its maximum usefulness will require the construction of the small dam between the island and the tow-head, and, probably, about 200 linear feet of brush and stone wall at the lower end of the island, as shown in red on the map. The current evinces a tendency to set in behind Island No. 1, above, enlarging the chute and disturbing the existing state of affairs in this locality. A dam 850 feet in length is projected to close this chute.

Proceeding downstream we come to Island No. 3, between which and the left bank of the mainland is a channel about 150 feet in width. To serve the double purpose of diverting the water from this channel and of maintaining the low-water width in the main channel at 400 feet, a jetty 600 feet in length is projected.

Good depth of water was found from this last-named point down to the head of Island No. 5, or Boom Island. The current above the head of the island sets strongly against the left bank, which is protected by a revetment constructed in 1878 about 1,100 feet in length, and by a low dam just below the point 300 feet in length. The channel behind Boom Island was at one time partially closed by *débris* of cribs, &c., but the floods of last season swept the material away, so that there is strong probability of a large volume of water taking this channel. To prevent such, and maintain the depth in the main channel, a dam 620 feet in length is proposed. A dam 200 feet in length across the slough, left bank, above Franconia, will assist in maintaining good depth over this stretch of river.

Just below Boom Island are the Osceola Islands, 7, 8, 9, and 10. The

steamboat channel here is along the left bank and in front of Osceola. It can be seen by the map that a large body of water flows behind Nos. 8, 9, and 10, to prevent which, as well as to maintain the depth necessary in the main channel, a series of dams, in all 1,425 feet in length, is proposed.

About 1 mile below Osceola are Islands Nos. 12, and 13, the latter known as Mile Island. The channel at this locality changed in direction, following the high water of last spring, and now passes to the left of Mile Island. One of the channels must be closed; probably the right-hand one. Two dams, of total length 800 feet, are proposed.

I may state here that all the dams and jetties proposed are not to have their upper surfaces more than 2 feet above low-water, and that their locations and dimensions are but approximate, as the channel may change before they can all be constructed.

About half a mile below Mile Island is the Limekiln Crossing, where trouble is frequently experienced by steamers at low-water stage. To contract the water-way here about 550 linear feet of brush and stone work will be necessary.

Just above Island No. 14 a dam or jetty 450 feet in length will be required.

Passing Island No. 16, the locality known as Cedar Bend is reached. The channel at this point has at times passed behind Islands 17 and 18. The channel marked as the East Slough also abstracts some of the volume of the river, and a large portion of the volume of discharge goes behind Island 19. The banks of the latter island and of the large island above it are cutting rapidly. About 1,550 linear feet of dams will be required here, and also about 1,000 linear feet of shore protection.

After leaving Cedar Bend no difficulty in navigation is experienced until reaching the foot of McLeod's Lake, where the width of stream increases, with a shoal-crossing. At this point, owing to the direction of the current, four short spurs on the left bank, aggregating in length 675 feet, will, it is thought, prove sufficient.

At Island 21 there is a shoal stretch of river, owing to the increased channel width. A series of dams and spurs, aggregating about 700 linear feet, is here proposed.

Just above the head of Island 22 (Pine Island) the channel again shoals. The channel appears to be changing in direction at this point, making towards the right bank, whence it will probably cross again to the opposite bank. It is probable that a jetty 600 feet long, as indicated on the map, will be required here. About opposite the middle of the island, the crossing, during the latter part of the season of 1879, was unusually shoal. This crossing was so improved by the construction of a jetty that no further work will probably be required here. The shore of Pine Island was revetted for a distance of 800 feet. The channel depth is now not less than 5 feet. The old line of piling below the jetty, shown by dotted black line and the hard bars surrounding it, aid in maintaining the flow of water along the right bank. Previous to the construction of the jetty we afforded some aid to steamers by scraping a temporary channel at the crossing.

The channel is generally good from this latter point, excepting at Island 25, where 250 feet of dam will be required, to the mass of islands and minor channels above Arcola, known as Page's Slough.

A large portion of the volume of discharge is diverted from the main river through these small channels, and the closure of a sufficient num-

ber of them by dams, as indicated on the map, will probably suffice for this portion of the river. Total length of dams about 400 feet.

Below Arcola, and as far down as Island No. 32, the channel is divided by islands. About 1,375 linear feet of dams required.

Between Islands 34 and 35 and the left bank is what is known as the Canal, a deepening of a secondary channel in 1867 by the logging interests for the benefit of steamers when the main river at this point is closed by booms and running logs. This canal is frequently used by steamers when logs run in great numbers. It is, however, narrow, and in some parts quite shoal. No estimate is rendered herewith for widening or deepening this canal, as it is the work of private parties, although opened by them to the public. No particular contraction of the river at this point appears necessary at present. The booms thrown across the river from this point for some miles above and below and the running of logs have always interfered with steamboat traffic more or less; but a more judicious location of pockets for the storage and assorting of logs has been made during the past season, lessening the difficulties of navigation in a degree. A few old cribs, piles, &c., may eventually require removal at this locality.

From the foot of the canal to Stillwater the channel is at present a good one. Just above Stillwater the main channel passes between Islands 43, 44, 45, and the left bank, bordered by high and firm bluffs; thence to the Stillwater wharf. Some interests desire the closing of the present (east) channel so as to deepen the west channel, in the hope of deepening the water along the Stillwater front. As such procedure would be attended with doubtful results, it does not seem advisable to go to such expense so long as a good channel (the east) already exists. The channels may of themselves change as desired in the course of years, though there are no indications at present of such change. Some few snags, &c., yet remain to be removed from the east channel, and the gaps between Islands 43, 44, and 45 may require closing by another season. Some revetment will also, probably, be necessary to preserve the islands which now bound the east channel; probably 300 linear feet of dams and 700 linear feet of revetment.

Stillwater is at the head of the Lake Saint Croix. The lake is here spanned by a bridge, with pontoon draw nearly 300 feet in the clear. The lake is about 23 miles long, averaging a little more than three-fourths of a mile in width. Its depth, excepting at the bars to be noted further on, is from 30 feet to 50 feet.

Just above Hudson, and about 6 miles below Stillwater, the lake is spanned by the Chicago, Saint Paul and Minneapolis line of railway bridge. The approach to the bridge consists of a long and high embankment, which infringes upon the width of the lake at least 1,200 feet. The bridge consists of one span about 140 feet in the clear at low-water, and a draw with spans of about 140 feet each in the clear. By reference to the map it will be seen that the draw-pier is badly located with reference to the direction of current, and that, in order to facilitate the passage of the west draw-span by rafts and steamers, a sheer-boom or line of piling should extend above the draw, and nearly on the prolongation of the axis of the draw-pier, for at least 1,000 feet, and some projecting points of bar be removed. No estimate is rendered for this, as it seems work pertaining to the bridge company.

The railroad embankment crosses a portion of what is known as Willow River Bar, a bar extending across the greater part of the lake just below the bridge, and for more than a mile down the lake, measured from the draw. The main channel, after passing the draw, lies along

the right bank, and is narrow and tortuous. This bar was no doubt originally caused by contributions of material from Willow River, brought down by floods. Of late years Willow River has been closed by a dam in order to create water-power, thus arresting its contributions. It is thought that by dredging the material between the line A B (see map) and the right bank so as to afford a depth of $4\frac{1}{2}$ feet, relief will be experienced for a number of years to come. Material to be removed, sand, gravel, clay, and a few boulders.

Estimate, 36,000 yards, at 30 cents per yard \$10,800

About 6 miles below Hudson Bridge is Catfish Bar, making out in a long spit from the left bank. The channel is narrow, and has sufficient depth, but when strong winds prevail its passage is troublesome to steamers, and especially to rafts. It is thought that by dredging out the prism of material bounded by the line C D on one side and the curved red line on the other to a depth of $4\frac{1}{2}$ feet, sufficient room will be afforded for a number of years to come. If it is found that Bowles' Creek contributes enough material to form the bar again, a curved dike, as indicated on the map in dotted red, can be established to train the material into deep water and out of the way; or a position for a dam, or other works, to arrest the movement of the material, may possibly be found within the limits of the creek itself. Material of bar, sand, gravel, clay, boulders.

Quantity to be removed, 20,000 cubic yards, at 30 cents per yard \$6,000

About $5\frac{1}{2}$ miles below Catfish Bar is Kinnickinnick Bar, doubtless due to contributions of material from the Kinnickinnick River, which enters from the left bank. The channel which lies to the westward of the bar is 500 feet in width and with good depth throughout. Unless this bar increases in width rapidly, nothing will be required at this point in the shape of improvement of navigation for many years to come.

A system of lights at Kinnickinnick, Catfish, and Willow River Bars, as well as at some few other points below Stillwater, is earnestly desired by those who navigate the lake.

Prescott, at the foot of the lake, is 6 miles below Kinnickinnick Bar. Nothing seems to be required here.

RECAPITULATION OF ESTIMATES.

11,800 linear feet of dams and jetties, averaging per linear foot \$2.75	\$32,450
2,000 linear feet of shore protection, at \$4	8,000
56,000 cubic yards of dredging, at 30 cents	16,800
Removing snags, stumps, leaning trees, old piers, &c	3,000
	<hr/>
	60,250

The sum of \$25,000 can be profitably expended during the fiscal year ending June 30, 1881.

Brush of proper size for the construction of dams cannot always be obtained in sufficient quantity in the immediate vicinity of a work.

Edgings from saw-mills have been used for the base of the revetment at Marine Bar, and, from the experience in using them thus far, they promise good results. The edgings are about 12 feet long and are made up into fascines, and from these, rafts or mats are made and sunk into position.

As regards the position of a wing-dam, or jetty, with reference to the current of the stream, considerable diversity of opinion exists. It would seem that no especial rule can be strictly followed. Dams projected in a

direction normal to the shore-line being shortest, require less material. Dams inclined downstream are subject to scour along the upstream face, besides protecting the shore just below their junction with it, less than those do which are inclined upstream. Dams inclined upstream, however, are subject to scour along the lower face. All three types must resist effect of overfall and scour around their heads. In the case of a stream like the Saint Croix, where many millions of logs are run down, it seems better to incline the dams downstream, generally, as such tend to sheer the logs into the main channel as the water subsides, keeping the logs from stranding upon them. There are several notable instances on this river of the effect of lines of piling inclined downstream to support booms placed for the purpose of guiding logs into the channel desired. A large sand-bar has almost invariably formed just underneath the line of piles, forming, with the piles themselves, a compact inclined jetty. The formation of a sand-bar below a line of piling is not, however, a matter of such certainty as to warrant the rejection of permanent brush and stone work.

Appended is a list of distances; also, statistics of the river; and, accompanying, are six tracings, on a scale of 1 inch to 400 feet, showing the stream from Taylor's Falls to Prescott; also, one tracing, showing cross-sections of dams and revetments constructed by the United States on the Saint Croix and Chippewa rivers, and which have endured well; also, tracing showing effect of jetties with different inclinations taken from a work on the improvement of the Rhine.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Table of distances on Saint Croix River, commencing at Taylor's Falls Bridge.

Island No.	Miles.	Island No.	Miles.	Island No.	Miles.
1	0.7	16	9.5	31	22.3
2	1.3	17	9.9	32	22.9
3	2.1	18	10.0	33	23.7
4	2.5	19	10.1	34	24.5
5 (Boom)	5.3	20	12.3	35	24.7
6	5.6	21	13.9	36	25.4
7	6.0	22 (Pine)	15.1	37	25.6
8	6.4	23	16.	38	25.9
9	6.6	24	17.	39	26.0
10 (Osceola)	6.7	25	19.3	40	26.1
11	7.4	26	20.5	41	26.4
12	7.8	27	20.8	42	26.7
13 (Mile)	8.0	28	21.2	43	27.0
14	9.3	29	21.4	44	27.1
15	9.4	30	21.7	45	27.2

	Miles.
To Stillwater Bridge	28.5
To Hudson Bridge	34.5
To Catfish Bar	40.1
To Kinnickinnick Bar	45.7
To Prescott	51.7

COMMERCIAL STATISTICS.

The Saint Croix River is in the collection-district of Minnesota. The nearest port of entry is that of Duluth, Minn., at which port \$7,764.51 of revenue was collected for the fiscal year ending June 30, 1879.

FREIGHT AND PASSENGERS.

There were three steamboats engaged exclusively in the freight and passenger business during the season of 1879, and from the statement it will be seen that the business done was large, when we take into consideration the length of river traversed—less than 60 miles. Of the three steamboats engaged, two plied between Hastings and Taylor's Falls, and commenced running on the opening of navigation; and the other between Stillwater and Taylor's Falls, and commenced running about August 1.

The figures below were furnished by Capt. John H. Reaney, of Saint Paul, Minn., and Capt. David Hays, of Osceola Mills, Wis., under whose directions the boats were operated.

Commodities.	Number of pounds carried up stream.	Number of pounds carried down stream.	Total number of pounds carried.
Flour.....	7,490,000	810,600	8,300,600
Wheat.....	17,244,000	8,207,895	25,451,895
Merchandise, &c.....	9,343,400	2,486,000	11,829,400
Lime.....	868,800	1,074,300	1,943,100
Bran and feed.....	87,500	.....	87,500
Barley.....	.....	60,000	60,000
Oats.....	.....	24,500	24,500
Salt.....	90,000	.....	90,000
Total.....	35,123,700	12,663,295	47,786,995

Passengers carried up and down stream, number, 9,244.

LOGS, LUMBER, RAFTING, AND TOWING, SEASON OF 1879.

Logs.—About 202,000,000 feet of logs passed through the Saint Croix boom during the season, which, at an estimated value of \$8 per thousand feet, would represent the sum of \$1,616,000. At the boom about 300 men were employed for 100 days.

Lumber.—There are ten large saw-mills on the Saint Croix River, seven of which are located at and around Stillwater, the head of Lake Saint Croix, and engaged in the manufacture of lumber. These seven mills cut during the season:

Lumber.....	feet..	83,727,820
Shingles.....	.....	40,238,000
Lath.....	.....	27,600,000

The estimated value of these products is about \$1,170,000. Expense attached to manufacturing the above, \$200,000. The other three mills are located at Franconia, Marine, and Glenmore. The amount of their business has not been obtained, but 8,000,000 feet would be a low estimate of the amount of lumber manufactured.

Rafting.—This branch of business requires a large force of men, carried on, however, during only a portion of the season. The amount of lumber rafted foots up 102,000,000 feet.

Towing.—There were twelve steamboats engaged in the towing of lumber and logs to various points during the season. The amount towed was 117,000,000 feet.